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Habitat associations of birds at Manton Dam, Northern Territory

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Abstract

Manton Dam is an impoundment of the Manton River approximately 50 km south-south-east of Darwin, Northern Territory. Major habitats associated with the dam (open water, water edge, riparian monsoon forest and savanna woodland) were searched to determine the bird species associated with each. A total of 84 avifauna species were recorded. Diversity (22 species) and abundance of waterbirds were low in comparison with other wetlands of northern Australia—only 11 bird species were recorded using the open water habitat. The paucity of waterbirds may be due to the lack of shallow foraging areas. Bushbirds included 50 species that used riparian monsoon forest habitat and 45 species that used savanna habitat; 34 species were recorded in both habitats. Nine waterbird species were also recorded using riparian monsoon forest habitat. Further development of riparian vegetation around the fringes of the dam may encourage colonisation by additional forest bird species. Increasing the extent of shallow water areas and prohibition of motorboats may enhance habitat availability and quality for waterbirds and shorebirds.

Introduction

Habitats for birds depend on the local geology, landforms, vegetation communities, and the presence and distribution of water. In the monsoon tropics, the distribution of vegetation communities is largely determined by position in the landscape, duration of inundation and availability of soil moisture (Taylor & Dunlop 1985; Bowman & Minchin 1987; Wilson & Bowman 1987; Cowie *et al.* 2000). Habitat development is a natural process that involves changes to the structural diversity and boundaries of vegetation over time. Vegetation patterns of the tropical savannas are particularly influenced by fire, soil moisture and longer term climatic and sea-level changes (Bowman & Minchin 1987; Bowman 1992; Williams 1994, 2001; Woinarski *et al.* 2004; Banfai & Bowman 2005). Land clearance for agriculture and housing, alteration of waterways by damming and other means, and the introduction of invasive species (weeds and feral animals) may also dramatically modify important habitats for birds.

Birds use habitats with varying degrees of specificity, influenced by vegetation structure, floristics, fire regime, and availability of resources including food,

water, cover and nesting sites such as trees, hollows, cliffs, etc. (Recher 1969; Rowley 1975; Rotenberry 1985; Franklin & Noske 1999; Noske & Franklin 1999; Woinarski 1990). Bird habitats in the Top End have been variously defined in relation to recognised vegetation communities (Crawford 1972; Morton & Brennan 1991; Woinarski *et al.* 1988, 2000; Goodfellow 2005; Reynolds 2010).

At Manton Dam, the Manton River (a tributary of the Adelaide River) has been blocked by the dam wall at a point where it once flowed through a gorge. An area that previously comprised a seasonal watercourse surrounded by savanna has been replaced by an extensive and permanent waterbody. Consequently, over the past 70 years, wetland and rainforest plants have colonised the riparian fringe. Other dam schemes in northern Australia, for example Lake Kununurra, Lake Argyle, Darwin River Dam, Fogg Dam, Lake Bennett and Lake Moondarra (Mt. Isa), have similarly resulted in changes to fringing vegetation (ANCA 1996).

Wetlands in the seasonally dry Top End support a distinct range of waterbirds and other avifauna species (Sedgwick 1946; Crawford 1979; Bamford 1990; Morton & Brennan 1991; Press *et al.* 1995; Cowie *et al.* 2000). Manton Dam provides habitat for waterbirds and is one of the few large, open, deep water bodies in the region. The establishment of riparian habitat around the fringes of the dam has been accompanied by the appearance of birds more associated with forested habitats. These riparian zones support a relatively high diversity of species, and birds are often more abundant in these zones (Woinarski *et al.* 2000). In this paper, I document the birds of Manton Dam and describe their habitat associations.

Methods

Study area

Manton Dam (12°50'S, 131°07E) is situated approximately 50 km south-south-east of Darwin (*c.* 70 km by road), Northern Territory (Figure 1). It was constructed during the Second World War and completed in 1942. Manton Dam was Darwin's first reliable water supply but was superseded in 1972 by the larger Darwin River Dam (Cramp 2005). Prior to its opening as a recreation area in 1989 the dam was drained and many tree stumps were removed (Boland 1995). Nowadays it is primarily used for recreational fishing and skiing (DIPE 2002). The surface area of the water occupies 360 ha, and the Manton Dam Recreation Area (NT Portion 3837) covers 11,600 ha (Boland 1995; DIPE 2002). Average depth is *c.* 4 m and the deepest point (near the dam wall) is *c.* 14 m when the dam is full (Boland 1995). The dam overflows in most years and there is drawdown of 1 to 1.5 m due to evaporation in the dry season (Townsend 1997), exposing the wetland fringe, with the lowest levels in November or December prior to the wet season monsoon rains (Townsend 1997).

Manton Dam provides some shallow, gently-shelving habitats restricted to the upper reaches where wet season creeks flow into the dam. Dead trees in these areas,

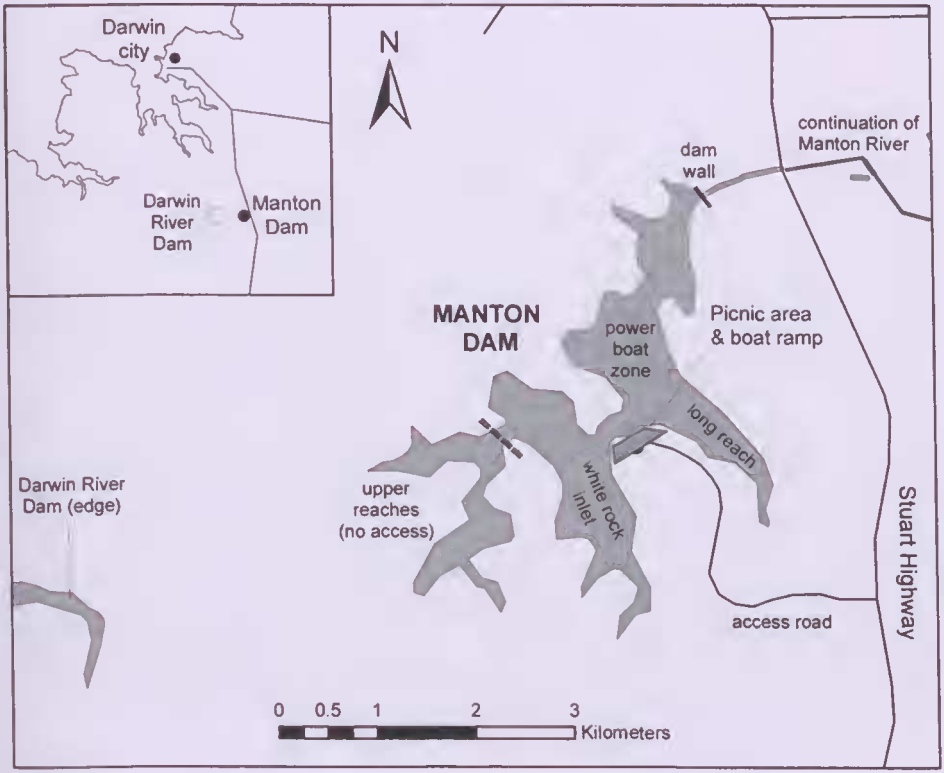

Figure 1. Map of Manton Dam and surrounding area, Northern Territory.

including long reach, provide important roosts for waterbirds, with little disturbance by motor boats. Fishers and skiers tend to restrict their activities to the main body of open water between the boat ramp and the dam wall (Figure 1).

Water temperatures are coolest between June and August (22-25°C) and warmest in December and March (31-32°C) (Townsend *et al.* 1997). Thermal stratification (warmer water at the top) occurs regularly and is particularly noticeable between August and December when there is no inflow (Townsend 1997).

Habitats

The main habitats associated with the dam include the open water (OW) of the dam proper, the water edge (WE) which includes the shallow margins and embayments (to 2-3 m depth) of the main waterbody, the riparian monsoon forest (RF) including a rainforest patch, and savanna woodland (SW) (Figures 2–3). Trees, shrubs and some

of the aquatic plants of the area were identified using Wightman and Andrews (1989), Brock (1993), Dunlop *et al.* (1995) and Cowie *et al.* (2000); older names have been updated where necessary.

Open water

The majority of OW habitat is deep and therefore not vegetated, although it covers many stumps of dead trees in peripheral areas. Much of the main body of the dam comprises OW habitat.

Water edge

In shallower water (WE habitat) sub-surface aquatic plants occur extensively, and include *Ceratophyllum* sp., *Hydrilla* sp. and *Myriophyllum* spp. (Townsend 1997). Emergent and surface aquatic plants occur only in WE habitat and include *Persicaria attenuata*, water lilies *Nymphaea violacea* and *Nymphoides indica*, and Spike Rush *Eleocharis sundaica* (Figure 2). The muddy fringes of the dam become exposed in the dry season and there is widespread evidence of damage by pigs in these areas.

Riparian monsoon forest

The riparian habitat (RF) varies considerably in extent and in areas with steep slopes it is only 2–3 m wide. This habitat supports *Pandanus spiralis*, River Pandanus *Pandanus aquaticus*, *Melaleuca* spp., patches of *Lophostemon lactifluus* and sporadic Leichhardt Trees *Nauclea orientalis*. In embayments along minor drainages and in other seasonally inundated areas, low *Melaleuca* forests of Silver-leaved Paperbark *M. argentea* and Weeping Paperbark *M. leucadendra* have developed (Figure 2); these communities have higher tree densities, higher litter cover and lower grass cover than surrounding savannas (Bowman 1992). Bases of the trunks of paperbarks (*Melaleuca* sp.) around the edge of the dam are partially submerged during the wet season and many have developed aerial roots.

Adjacent to the picnic area is a patch of closed rainforest (included in RF habitat) which supports approximately 30 species of trees and shrubs (only the more common or obvious species are listed here). The overstorey is dominated by Black Wattle *Acacia auriculiformis*, Freshwater Mangrove *Barringtonia acutangula*, Leichhardt Tree *Nauclea orientalis* and *Carallia brachiata*. In the small tree layer *Timonius timon*, *Cyclophyllum schultzii*, *Breynia cernua*, *Exocarpos latifolius* and the palm *Livistona benthamii* are common. Vines and climbers include Fountain Bush *Opilia amentacea*, Supplejack *Flagellaria indica*, *Smilax australis* and Snake Vine *Tinospora smilacina*. Banyan *Ficus virens* and Weeping Fig *F. benjamina* occur patchily and shade out or strangle other trees. *Canarium australianum* is common but occurs primarily as saplings. Species that are escapees or plantings include *F. benjamina*, White Cheesewood *Alstonia scholaris* and Mango *Mangifera indica*. Grassed parts of the picnic area are mown regularly, and watering by sprinklers at night provides a potential source of drinking water for some birds.

Figure 2. Habitats at Manton Dam: open water habitat in the foreground, and fringing water edge habitat with water lilies and rushes; in the background, seasonally inundated riparian (*Melaleuca*) monsoon forest. (S. Reynolds)

Savanna woodland

Savanna woodland (SW habitat) exists on the stony low hills surrounding the dam (Figure 3). Common tree species are Ironwood *Erythrophleum chlorostachys,* several species of eucalypts (*Corymbia polysciada*, *Eucalyptus tectifica* and Stringybark *E. tetrodonta*), Billy Goat Plum *Terminalia ferdinandiana, Owenia vernicosa,* Cocky Apple *Planchonia careya,* Cycad *Cycas armstrongii* and Sand Palm *Livistona humilis.* Turkey Bush *Calytrix exstipulata* and Kapok Bush *Cochlospermum fraseri* occur in patches. The presence and abundance of native savanna plants is influenced by regular dry season burning (Russell-Smith *et al.* 2010; Bond *et al.* 2012), as is the widespread occurrence of the invasive weeds Mission Grass *Pennisetum poystachion* and *Hyptis suaveolans.* Wild Passion Fruit *Passiflora foetida* was also common. Large boulders and stony ridges provide protection from fire in the savanna matrix (Fensham 2012) and these sites support additional species including *Pouteria sericea,* Banyan *Ficus virens* and *Denhamia obscura.*

Figure 3. Example of savanna woodland habitat on stony ground in the dry season. The area includes a stand of the Sand Palm *Livistona humilis* and a eucalypt overstorey. (S. Reynolds)

Avifauna Surveys

During surveys for Merten's Water Monitor *Varanus mertensi* at Manton Dam in April 2005, I made opportunistic observations on the bird life of the area. The dam was visited on four occasions during this period for approximately 12 h on each day (from sunrise to sunset). Survey methods involved aural and visual surveys of the waterbody (OW and WE habitats) and fringing vegetation (RF habitat) as I travelled around the fringes of the dam and as far as the dam wall by boat (Figure 1). The surveys also incorporated areas in the upper reaches of the dam that are not usually accessible by boat (Figure 1). Surveys by boat were made in the early morning, in the late afternoon, and occasionally at other times of the day. The remainder of the time was spent in the picnic area (located at 12°51'44"S, 131°07'15"E) and its immediate surrounds (generally within 300 m of the boat ramp) where observational surveys were made on foot, and aural surveys were conducted by sitting in one place and recording all species heard (and seen) for periods of 30-60 minutes.

The dam was revisited for two days in August 2010 (for approx. 12 h, from sunrise to sunset) and a further day in late September 2011 during which I surveyed the waterways by kayak and the picnic area and access road on foot. The surveys by kayak focused on long reach and white rock inlet (Figure 1). Thus, the total number of survey days during the study was seven.

Observations were mainly undertaken during periods of partially cloudy, warm (28-33°C) and moderately humid weather. All bird species within each habitat were recorded. Species not immediately distinguishable by eye were identified with the aid of binoculars. Birds flying overhead were assigned to the habitat in which they were foraging (e.g. Whistling Kite, White-bellied Sea-Eagle, Tree Martin) or passing through (e.g. Varied Lorikeet). Egrets and other waterbirds passing over OW and SW habitats while travelling to roosting or foraging areas were not included, but a waterbird was considered to be using OW habitat if it was swimming in (e.g. cormorants) or on (e.g. Green Pygmy-goose) the water.

Avifauna nomenclature and family sequence follows Christidis and Boles (2008). Several taxa considered to be full species by Schodde and Mason (1999) are listed as subspecies.

Results

A total of 84 species was recorded across all habitats during the survey at Manton Dam (Table 1). The Australasian Darter, Whistling Kite and 17 of the bushbirds were recorded on all seven survey days. In contrast, Pink-eared Duck, Black Bittern, Black Falcon, Brolga, Tawny Frogmouth, Azure Kingfisher and Dusky Honeyeater were recorded only once. Magpie Goose was the most abundant waterbird species (maximum count 180) and Wandering Whistling-Duck (maximum count 120) was the second most abundant. The resident Green Pygmy-goose was the third most abundant waterbird species, occurring in OW habitat and amongst floating aquatic vegetation in WE habitat. Counts of all other waterbird species were fewer than 25 individuals (Table 1).

Habitats

Open water

A total of 11 species was observed using OW habitat, comprising eight species of waterbird (Table 1), two species of raptor (White-bellied Sea-Eagle and Whistling Kite) and Tree Martin (Table 1). With the exception of Green Pygmy-goose, Little Pied Cormorant and Little Black Cormorant, waterbirds occurred in low numbers. Cormorants and Australasian Darter were recorded during all surveys. Two Pink-eared Ducks were also recorded in OW habitat (Table 1).

Water edge

A total of 24 species was recorded in WE habitat, comprising 18 species of waterbird (Table 1), two species of raptor (White-bellied Sea-Eagle and Whistling Kite), Masked Lapwing, Azure Kingfisher, White-breasted Woodswallow and Tree Martin. Most waterbirds were observed foraging along the shore or in water less than 0.5 m deep. Egrets used the shallow water amongst reeds, whereas Radjah Shelduck occupied wet grassy edges. In September, towards the end of the dry season, waterbird numbers increased, and counts of cormorants, Wandering Whistling-Duck, Intermediate Egret and Comb-crested Jacana peaked at long reach. A solitary Common Greenshank was the only migratory shorebird observed.

Riparian monsoon forest

Avifaunal species richness was highest in RF habitat (59 species). Nine species of waterbird (Table 1) were observed in RF habitat, usually encountered in the fringing *Melaleuca* forest. Forest Kingfisher was found in and adjacent to the rainforest patch, where I located a nest in an arboreal termitarium some 12 m above the ground. Most fruit-eating birds, such as Pied Imperial-Pigeon, Australasian Figbird and orioles, occurred exclusively in this habitat. Sulphur-crested Cockatoo was usually recorded in RF habitat, but also occurred in SW habitat. Rainbow Lorikeet was attracted to paperbark blossom in RF habitat, but also fed on eucalypt (*Eucalyptus* spp. and *Corymbia* spp.) blossom in SW habitat. Owls were only recorded in RF habitat; one or more Barking Owls were heard regularly in the early evening calling from near the boat ramp. Northern Fantail was mainly encountered in RF habitat, but it also occurred on the fringes of SW habitat.

Savanna woodland

Fewer species were recorded in SW habitat than in RF habitat. Eleven species were found exclusively in SW habitat, including Black Falcon, Black-tailed Treecreeper, Weebill, Red-backed Fairy-wren and Rufous Whistler (Table 1). Except for Rufous-banded Honeyeater, which was only recorded in RF habitat, seven out of eight species of honeyeaters recorded during this study occurred in SW habitat and White-throated Honeyeater was only recorded from SW habitat. No species of waterbird were recorded using this habitat (Table 1).

Thirty-four species that occurred in RF habitat were also recorded in SW habitat (Table 1). Red-winged Parrot was mostly observed in SW habitat, and only sometimes in RF habitat. Leaden Flycatcher occurred in both habitats. Blue-winged Kookaburra was common in RF and SW areas and Brown Goshawk was also observed several times using RF and SW habitat.

Table 1. Bird species recorded in various habitats at Manton Dam. Frequency (F) is the number of survey days (maximum 7) for which each species was recorded. Count (C) is the maximum number of waterbirds observed. Habitat categories are as follows: OW = open water, WE = water edge, RF = riparian monsoon forest, SW = savanna woodland.

Species	F	C	OW	WE	RF	SW
Brown Quail *Coturnix ypsilophora*	1				x	x
Magpie Goose *Anseranas semipalmata*	2	180	x	x	x	
Pink-eared Duck *Malacorhynchus membranaceus*	1	2	x			
Green Pygmy-goose *Nettapus pulchellus*	6	100	x	x		
Radjah Shelduck *Tadorna radjah*	2	3		x	x	
Wandering Whistling-Duck *Dendrocygna arcuata*	2	120		x	x	
Australasian Grebe *Tachybaptus novaehollandiae*	1	1	x			
Australasian Darter *Anhinga melanogaster*	7	6	x	x		
Little Pied Cormorant *Microcarbo melanoleucos*	6	18	x	x		
Little Black Cormorant *Phalacrocorax sulcirostris*	5	24	x	x		
White-necked Heron *Ardea pacifica*	1	1		x		
Pied Heron *Ardea picata*	1	6		x		
Black Bittern *Ixobrychus flavicollis*	1	1		x	x	
Eastern Great Egret *Ardea modesta*	1	2		x		
Intermediate Egret *Ardea intermedia*	3	5		x		
Cattle Egret *Ardea ibis*	2	15		x	x	
Australian White Ibis *Threskiornis molucca*	2	4		x	x	
Straw-necked Ibis *Threskiornis spinicollis*	2	5		x	x	
Black-necked Stork *Ephippiorhynchus asiaticus*	3	2		x	x	
White-bellied Sea-Eagle *Haliaeetus leucogaster*	3		x	x	x	
Whistling Kite *Haliastur sphenurus*	7		x	x	x	x
Black Kite *Milvus migrans*	2				x	x
Brown Goshawk *Accipiter fasciatus*	3				x	x
Black Falcon *Falco subniger*	1					x
Brolga *Grus rubicunda*	1	2			x	
Greenshank *Tringa nebularia*	1	1		x		
Masked Lapwing *Vanellus miles*	3			x	x	

Table 1. Continued.

Species	F	C	OW	WE	RF	SW
Comb-crested Jacana *Irediparra gallinacea*	2	16		x		
Bush Stone-curlew *Esacus magnirostris*	2				x	x
Whiskered Tern *Chlidonias hybridus*	1	2	x			
Emerald Dove *Chalcophaps indica*	2				x	
Pied Imperial-Pigeon *Ducula bicolor*	3				x	
Bar-shouldered Dove *Geopelia humeralis*	7				x	x
Peaceful Dove *Geopelia striata*	7				x	x
Sulphur-crested Cockatoo *Cacatua galerita*	7				x	x
Red-tailed Black Cockatoo *Calyptorhynchus banksii*	3					x
Red-winged Parrot *Aprosmictus erythropterus*	7				x	x
Varied Lorikeet *Psitteuteles versicolor*	6					x
Rainbow Lorikeet *Trichoglossus haematodus rubritorquis*	7				x	x
Pheasant Coucal *Centropus phasianinus*	3				x	x
Brush Cuckoo *Cacomantis variolosus*	1				x	x
Tawny Frogmouth *Podargus strigoides*	1				x	x
Barking Owl *Ninox connivens*	5				x	
Azure Kingfisher *Ceyx azureus*	1			x	x	
Blue-winged Kookaburra *Dacelo leachii*	7				x	x
Forest Kingfisher *Todiramphus macleayii*	7				x	x
Sacred Kingfisher *Todiramphus sanctus*	5				x	x
Rainbow Bee-eater *Merops ornatus*	6				x	x
Black-tailed Treecreeper *Climacteris melanura*	5					x
Great Bowerbird *Ptilonorhynchus nuchalis*	7				x	x
Red-backed Fairy-wren *Malurus melanocephalus*	3					x
Striated Pardalote *Pardalotus striatus*	2					x
Weebill *Smicrornis brevirostris*	4					x
Silver-crowned Friarbird *Philemon argenticeps*	2				x	x
Little Friarbird *Philemon citreogularis*	4				x	x
Blue-faced Honeyeater *Entomyzon cyanotis*	3				x	x
White-gaped Honeyeater *Lichenostomus unicolor*	7				x	x
White-throated Honeyeater *Melithreptus albogularis*	7					x

Table 1. Continued.

Species	F	C	OW	WE	RF	SW
Rufous-banded Honeyeater *Conopophila albogularis*	2				x	
Brown Honeyeater *Lichmera indistincta*	7				x	x
Dusky Honeyeater *Myzomela obscura*	1				x	x
Grey-crowned Babbler *Pomatostomus temporalis*	1				x	x
White-bellied Cuckoo-shrike *Coracina papuensis*	7				x	x
Varied Triller *Lalage leucomela*	3				x	
Grey Shrike-Thrush *Colluricincla harmonica*	4					x
Rufous Whistler *Pachycephala rufiventris*	2					x
Australasian Figbird *Sphecotheres vieilloti*	4				x	
Yellow Oriole *Oriolus flavocinctus*	7				x	
Olive-backed Oriole *Oriolus sagittatus*	2				x	
White-breasted Woodswallow *Artamus leucorhynchus*	4			x	x	
Grey Butcherbird *Cracticus torquatus argenteus*	4				x	x
Spangled Drongo *Dicrurus bracteatus*	7				x	x
Willie Wagtail *Rhipidura leucophrys*	5					x
Northern Fantail *Rhipidura rufiventris*	6				x	x
Torresian Crow *Corvus orru*	7				x	x
Shining Flycatcher *Myiagra alecto*	7				x	
Restless Flycatcher *Myiagra inquieta nana*	4				x	
Leaden Flycatcher *Myiagra rubecula*	4				x	x
Australian Magpie-lark *Grallina cyanoleuca*	2				x	x
Lemon-bellied Flycatcher *Microeca flavigaster*	7				x	
Mistletoebird *Dicaeum hirundinaceum*	6				x	x
Tree Martin *Petrochelidon nigricans*	1		x	x		
Crimson Finch *Neochmia phaeton*	1				x	
Double-barred Finch *Taeniopygia bichenovii*	1				x	x
Total species			11	24	59	45

Discussion

Surveys of the avifauna at Manton Dam revealed an abundant bird fauna, with 84 species recorded. However, compared with other wetland sites in northern Australia, Manton Dam has a low diversity of waterbirds (22 species). For example, at Fiddlers Lane (Knuckeys Lagoon), a comparatively small wetland near Darwin, 30 waterbird and 10 wader species have been recorded (S. Reynolds, unpubl.). At Kidneybean Claypan on Roebuck Plains near Broome, 35 waterbird and more than 20 wader species have been observed (Rogers *et al.* 2001), and at Fogg Dam 39 waterbird species have been recorded (Crawford 1979). The freshwater wetlands of Kakadu National Park support more than 40 species of waterbird and 20 species of shorebird (Bamford 1990; Press *et al.* 1995). At Lake Kununurra (an impoundment of the Ord River, Western Australia), 55 waterbird species have been recorded, including 18 breeding at the site. Lake Argyle in the Kimberley, an important dry season refuge, supports 48 species of waterbird and 26 species of shorebird (ANCA 1996).

Natural water bodies in northern Australia, including lagoons and floodplains, expand and contract dramatically over the course of the year with many areas drying out completely (Finlayson *et al.* 1990; Kingston 1991; Cowie *et al.* 2000). The shallow and exposed muddy fringes of wetlands provide an important food resource for waterbirds that have adopted a range of foraging strategies specifically for such habitats (Cowie *et al.* 2000; Morton & Brennan 1991). In contrast to many wetlands where waterbirds congregate during the dry season (Crawford 1979), and the floodplains of Kakadu, where ducks, herons, egrets and ibis may occur in the thousands (Morton *et al.* 1990, 1993), Manton Dam is a poor dry season refuge. Therefore, it is not surprising that of the nomadic ducks (e.g. Grey Teal *Anas gracilis*) and herons (e.g. White-faced Heron *Egretta novaehollandiae*) from southern Australia that seek out shallow freshwater swamps in monsoonal northern Australia (Morton & Brennan 1991), only Pink-eared Duck was recorded (Table 1). The shallow water habitat of Manton Dam was used by egrets, Radjah Shelduck and Magpie Geese, as well as Green Pygmy-geese which feed on aquatic plants (Blakers *et al.* 1984). The relatively deep water (average 4 m) of Manton Dam provided good foraging habitat for the Australasian Darter and cormorants.

In the Kimberley of Western Australia and the Top End of the Northern Territory rainforest occurs as patches (Russell-Smith 1991; Price 2006). Johnstone and Burbidge (1991) identified a range of bird species that are largely confined to rainforest in the Kimberley. Of these species, Pied Imperial-Pigeon, Emerald Dove, Varied Triller, Yellow Oriole, Australasian Figbird and Spangled Drongo were recorded from the rainforest patch at Manton Dam. A range of species (Brown Goshawk, Bar-shouldered Dove, Peaceful Dove, Blue-winged Kookaburra, Northern Fantail, Leaden Flycatcher, and Double-barred Finch) tend to be more abundant in riparian forests than in adjacent habitats (Woinarski *et al.* 2000); in this study these species

were all recorded from both rainforest and woodland habitats. Barking Owl and the nests of several species (Lemon-bellied Flycatcher, Shining Flycatcher, White-bellied Sea-Eagle and Forest Kingfisher) were only found in rainforest habitat.

The greater density of trees, structural diversity, and enhanced availability of cover, nesting and food resources in riparian and rainforest habitats account for the greater diversity of bird species in these habitats compared with savanna woodland (Johnstone & Burbidge 1991; Woinarski *et al.* 2000). The difference in species richness between the two habitats (RF: 59, SW: 45) in this study is likely to be at least partly due to these factors.

Fruiting trees were mainly found in rainforest habitat in this study; they are commonly associated with monsoon forests where they may produce thousands of fruit per tree (Bach 1998) and are an important resource for frugivorous birds. Australasian Figbird and Varied Triller are particularly attracted to figs (Storr 1980) and were observed feeding on the small fruit of *Ficus virens* in September, along with White-bellied Cuckoo-shrike and Mistletoebird. Great Bowerbird is known to consume the fruit of *Canarium australianum* and, near the picnic area, this bird may have been a factor in the dispersal of this pioneer species (Bach 1998). The fruit of *Carallia brachiata, Breynia cernua, Alphitonia excelsa, Pouteria sericea* and *Opilia amentacea* are also likely to have been dispersed by birds (Wightman & Andrews 1989). Frugivorous birds, such as Yellow Oriole, Australasian Figbird and Pied Imperial-Pigeon, are important seed dispersers and occurred only in rainforest habitat. Frugivores can digest the outer pericarp of fruit but not the seed, which is left intact. The seeds can then be deposited when these birds move between monsoon forest patches, distances of up to 10 km (Price 2006).

Numbers of honeyeaters, the most diverse passerine family in this study (Table 1), fluctuated in response to the flowering of paperbarks around the dam. For example, Brown Honeyeater was highly abundant during most surveys but was represented by a single record in September 2011. It is likely that other honeyeater species occur at Manton Dam when different plants are flowering.

Among raptors, Whistling Kites were frequently present near water in low numbers and a Black Kite was observed at fires in woodland habitat in late April. White-bellied Sea-Eagles were observed on a nest at the east side of the dam in 2005 and 2010, but no nests were present in 2011. This species may occur far inland, as for example at Lake Argyle (Storr 1980), and will colonise and breed on most large reservoirs (Blakers *et al.* 1984).

Species which occur at low densities, are seasonal or nomadic visitors, or which are relatively inconspicuous to an observer, are often infrequently recorded (Reynolds 2010). In this study, the secretive Black Bittern was observed only once, in fringing paperbark forest. Black Bitterns occupy dense waterside vegetation

(Storr 1980) and, although generally nocturnal or crepuscular, can sometimes be flushed during the day (Sedgwick 1946).

Species not recorded that are likely to occur at Manton Dam include seasonal or nomadic visitors (Dollarbird *Eurystomus orientalis*, Eastern Koel *Eudynamys orientalis*, Bar-breasted Honeyeater *Ramsayornis fasciatus*), uncommon species (Northern Rosella *Platycercus venustus*, Grey Goshawk *Accipiter novaehollandiae*, Buff-sided Robin *Poecilodryas cerviniventris*), rainforest inhabitants (Green-backed Gerygone *Gerygone chloronata*, Rainbow Pitta *Pitta iris*), nocturnal species and other waterbirds and raptors. Surveys in the wet season would likely uncover additional seasonal visitors, and surveys of the wetland fringes as they become exposed in the late dry season (September-November) may uncover migratory shorebirds on their southern migration (Shurcliff 1993). Interestingly, it was not until 2011 that any Crimson Finch were observed in the stands of *Pandanus* (RF habitat), a vegetation type where this species is usually abundant. I am unable to account for the unusually low density of this species at Manton Dam despite apparently suitable habitat.

In summary, the extensive distribution of riparian forest around the dam provides comparatively large areas of habitat suitable for a range of bushbirds. By contrast, the observed diversity of waterbirds was poor in comparison to other water bodies in Northern Australia. Changes in vegetation and the presence of permanent water are likely to have influenced the diversity and species composition of the birdlife, and further surveys may uncover additional species utilising the area. Habitat quality for wading birds could be improved by landscaping parts of the dam to provide gently shelving areas with exposed muddy fringes which are important foraging sites for waterbirds, thus increasing the area's similarity to other wetlands that act as important dry season refuges. If Manton Dam again becomes a water supply for Darwin (as has been mooted), it may be closed to motorised craft, which may encourage more waterbirds to use the wetland area.

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